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Sleep disorder prevalence in at-risk adolescents and potential effects of nightmare triad syndrome

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Abstract:
Objective: At-risk high school students, those considered to have a higher probability for academic failure or dropping out, were assessed for various sleep disorders. Effects were compared between students with and without the nightmare triad syndrome (NTS+), the sleep disorders' cluster of frequent nightmares, insomnia disorder and suspected sleep-disordered breathing (SDB).
Methods: Data were gathered at a charter school for at-risk youth using: computer based surveys, physical airway exams, and mental health interviews by school social worker. Ninety-two students were enrolled, and 70 completed all study components.
Results: Students were teenaged [17.10 (1.50) years], male (52.2%) slightly overweight [BMI 25.50 (6.41)] Hispanics (87.0%); two-thirds (65 of 92) subjectively reported a sleep problem. Frequent nightmares (39.1%), insomnia (ISI $\geq$ 12, 41.3%), and SDB risk (79.3%) were common. Several presumptive sleep disorders (insomnia, SDB risk, parasomnia, or nightmares) were associated with worse sleep quality and lower quality of life. Nineteen students met criteria for NTS. Compared to NTS−, NTS+ showed significantly lower quality of life ($p < 0.003$, $g = 0.84$). Regression analyses revealed higher levels of depression and anxiety symptoms in NTS+ students. NTS was associated with reduced quality of life independent of anxiety symptoms.
Conclusion: Prevalence of presumptive sleep disorders was high with a tendency for clusters of sleep disorders in the same individual. Students with NTS+ showed worse outcomes and reduced quality of life, mediated partially by depression and anxiety. To examine relationships between sleep disorders and mental health in at-risk adolescents, research investigations must include both subjective and objective measurements of sleep.

Keywords: anxiety, depression, insomnia, nightmares, sleep-disordered breathing, quality of life
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Introduction

At-risk adolescent students are those who suffer academically due to emotional or behavioral problems [1]. Substance abuse [2], [3], mental health disorders [4], and truancy [5] are common issues among at-risk students, and lead to suspension, expulsion, or dropping out of school, any of which further compromise academic performance [1]. Vulnerable high school students (grades 9–12, aged 14–20) report numerous mental and physical health risks as well as higher rates of anxiety and depression [6], [7], [8]. Mental health and behavioral health are also adversely affected by sleep disorders [9], [10], [11], [12], [13], [14], [15].

Sleep disorders present with greater variability in youth [16], [17], [18], [19]. Adults typically remain sedentary when sleepy or tired whereas, youth may be hyperactive, using movement and disruptive behavior as stimulation [20], [21]; hyperactivity decreases when sleep problems are addressed [22]. Common sleep disorders in adolescents include insomnia, nightmares, and sleep apnea [23], [24], [25]. Common sequelae among adolescents include daytime sleepiness from insufficient sleep [10], [26], sleepiness and fatigue from less total sleep time due to nightmares, [27] and, poor sleep quality due to sleep fragmentation from sleep apnea [28].

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Sleep disorders not only affect academic performance as these students report difficulty waking up in the morning, getting to class on time, staying awake in class, and completing assignments [10], [26], [29], [30], [31], but sleep disorders also lead to substance abuse, exacerbation of mental health disorders, and poor decision making [9], [32], [33], [34]. Further, adolescents with complex or co-morbid sleep disorders suffer increased negative consequences in well-being and quality of life [1], [17]. Although at-risk students are as susceptible, if not more so, to mental, emotional, behavioral, and physical health risks compared to normal high schoolers [1], scant research has examined sleep disorders and their effects in this population; even less research examined clusters of sleep disorders arising within individual cases among at-risk adolescents.

Since 2011 we have studied sleep disorders in at-risk high school students in the Southwestern US. Initial pilot work revealed high risk or prevalence for multiple, co-occurring sleep disorders, namely insomnia disorder, nightmare disorder, and risk for sleep disordered breathing (SDB). One fifth of students presented with this triad of co-morbid disorders (nightmare, insomnia, and clear risk for SDB), described as the nightmare triad syndrome (NTS) [35], [36]. The co-occurrence of these three sleep disorders is especially interesting because not only do each of these disorders aggravate sleep fragmentation [37], [38] but they appear to exacerbate each other [38], [39], [40], [41], [42]. Moreover, treatments for insomnia, nightmares, or SDB all share an objective to improve sleep consolidation and therefore may have therapeutic effects on other sleep disorders. In fact, recent research shows that treatment of any one of these disorders may improve or otherwise favorably influence the other two: treating SDB can decrease insomnia and nightmares [43], [44], [45], [46]; insomnia treatment may consolidate sleep and reduce awareness of nightmares [47], as well as improve fragmentation and increase total sleep time in SDB patients [48]; last, nightmare treatment can improve poor sleep quality and decrease insomnia [49], [50]. Hypotheses:

The current study examined prevalence of sleep disorders and compared those with multiple sleep disorders clustered in a pattern consistent with NTS+ and those without NTS–. We hypothesized:

- At least 50% of a select sample of at-risk high school students will report multiple symptoms due to diagnosable or apparent psychological or physiological sleep disorders.
- Sleep quality and quality of life would be significantly worse in students with symptoms of a sleep disorder (e.g. insomnia, frequent nightmares, SDB risk, parasomnia/leg movement symptoms) compared to those without a sleep disorder.
- A substantial minority of cases would meet NTS+ criteria and manifest significantly worse quality of life than NTS− students.
- NTS+ participants would report significantly higher depression, anxiety and suicidality scores than the NTS− group
- NTS will be independently associated with lower quality of life independent of symptoms of depression or anxiety.

Materials and methods

Consent

This epidemiologic protocol administered sleep and mental health questionnaires to determine prevalence of sleep and mental health symptoms in at-risk adolescents at a Southwest US charter high school. Approval of study protocol and informed consent form was given by Presbyterian Medical Center Institutional Review Board, Albuquerque, NM, permitting the Sleep and Human Health Institute to use data for research purposes and by Mississippi State University's Institutional Review Board permitting data analysis; all authors complied with the World Medical Association Declaration of Helsinki regarding ethical conduct of research involving human subjects.

Population

The school serves grades 9–12, comprising at-risk adolescents, aged 14+. Average student body during the school year is 190 students, but due to high turnover, new orientation classes occur throughout the year; total yearly enrollment is 225–275. Students are mostly minorities (95%) from economically disadvantaged homes (98%). Within any given 60-day period, 10% of the school population has used opiates. This school was founded

for students who previously dropped out, were expelled, are behind academically, or need additional support not available in a traditional high school.

Inclusion and exclusion criteria

All students attending the charter school were eligible to participate including students taking drugs such as Methadone or Suboxone under medical supervision, or medications for mental health prescribed by a physician. Acutely psychotic, intoxicated, in withdrawal, or mentally unstable students requiring urgent treatment outside the school environment were ineligible.

Procedure

We worked closely with school officials and support staff to integrate this protocol into the academic environment. Cross-collaboration between study researchers and school staff was necessary to identify actively suicidal or mentally unstable individuals. Study overview was given during a staff meeting. Due to inconsistent parental involvement, consent was obtained for under-aged students while parents were on campus during registration or parent/teacher conferences, resulting in selection bias, presuming parents aware of children's sleep problems were more motivated to enroll the student. The project was discussed during homeroom and all-school announcements. Enrollment was ongoing for five consecutive semesters (Fall 2011–Fall 2013) in an effort to enroll 100 students. Selection bias likely also occurred among those students with self-reported sleep complaints.

Students completed web-based questionnaires in a computer lab, taking an average 75 min (range 45–120 min) during school hours. Bilingual staff were available to translate questionnaires verbally on an individual basis. Research staff addressed questions and assisted as needed. Following questionnaire completion, the second author conducted individual nasal/oral airway physical exams. Within 2 months of completing computer-based questionnaires, students met with their school appointed social worker who conducted individual formal diagnostic interviews on psychological disorders to assess post-traumatic stress disorder (PTSD), depression, and anxiety types; suicidal ideation and presence of traumatic imagery were also evaluated.

All data were compiled into individualized sleep evaluation reports that students reviewed with research staff. A resource list of local providers for further evaluation or treatment was available through the students' social workers.

Computer based questionnaires

The questionnaire set included 12 online surveys [51]: a standard socio-demographic and lifestyle questionnaire, sleep perceptions (ASKME-30), insomnia severity index (ISI) [52], time monitoring and calculating behavior [53], caffeine intake, sleep hygiene checklist, disturbing dreams and nightmare severity index (DDNSI) [54], Epworth sleepiness scale (ESS) (Adolescent Version) [55], nasal oral systems evaluation, insomnia impairment index (III), sleep disordered breathing questionnaire (SDB-6), and Pediatric Quality of Life Enjoyment and Satisfaction Questionnaire-Short Form (PQ-LES-Q) [56]. Scoring details are provided in (Supplement).

Physical exam of nasal/oral airway

The second author, a board-certified internist and sleep medicine specialist, conducted the physical airway assessment with research staff recording the findings. Nasal septum, turbinates, congestion, bite, dentition, dental arch shape, tongue, hard palate, soft palate, uvula, nasal and oral airway, tonsils, and chin morphology were evaluated with special attention given to cranio-facial features indicative of risk for upper airway resistance syndrome (UARS) [57]. The Mallampati scale assessed airway crowding [58], [59], [60].

Individual mental health interview

Beck depression inventory-II [61], beck anxiety inventory [62], depressive symptom index suicidality subscale [63], trauma imagery scale [51], and PTSD section of the Kiddie Schedule for Affective Disorders and Schizophrenia Present and Lifetime version [64] were completed during individual semi-structured mental health interviews with school social workers. See (Supplement) for scoring details.

SDB risk

SDB risk screening assessed multiple algorithms based on subjective symptoms and objective signs; in children and adolescents combinations of factors are necessary to establish risk [65]. Those at greatest risk for sleep apnea reported non-restorative sleep (NRS) (aka poor sleep quality) and subjective report of witnessed cessation of breath or choking/gasping/struggling for breath, because of likely apneic events. A second assessment for risk included students who reported snoring, NRS, and BMI > 29.9 or at least one of three physical attributes: tonsil size ≥+3, Mallampati score +3, or UARS anatomical cluster [57]. A final evaluation of presumptive SDB included students with NRS and at least 4 of 6 End Organ symptoms on the SDB-6: difficulty paying attention, trouble concentrating, difficulty remembering things, dry mouth upon awakening, morning headache, and nocturia [66], [67], [68], [69].

Nightmare triad syndrome

The NTS conceptualization is still in development, but includes those suffering from three co-occurring diagnosable or presumptive sleep disorders: nightmare disorder, insomnia disorder, and SDB. At its most pronounced form in adults we presume DDNSI ≥ 10, ISI ≥ 15, and objective diagnosis of OSA/UARS. For exploratory purposes in adolescents we chose to consider a more liberal definition to test whether the presence of NTS is relevant: monthly nightmare frequency with related impairment, ISI ≥ 12 [70] with related impairment, and moderate to high probability of a sleep breathing disorder.

Statistical analyses

Descriptive statistics were provided on student sleep complaints and presumptive sleep disorders, including associations with NRS and quality of life. All continuous variables expressed as mean (SD) and dichotomous variables expressed as n (%). Analysis of variance (ANOVA) was used to compare groups with Hedge's g effect sizes due to unequal sample sizes; p-value <0.01 indicated significance. We utilized PROCESS model 4 to test whether a direct effect of NTS on quality of life remained after controlling for depression or anxiety symptoms. We utilized a 95% bias-corrected bootstrap model with intervals resampled 5000 times for each analysis [71].

Results

Population

A total of 119 consent forms were signed of which 92 students completed the intake questionnaire, 90 completed the airway exam, and 71 completed the mental health interview (Figure 1). The 92 were predominately teenaged 17.10 (1.50) years, male 48 (52.2%), slightly overweight [BMI 25.50 (6.41)], and Hispanic 80 (87.0%). At least one mental health disorder was subjectively reported in 33 (35.9%) students. Twenty two (23.9%) students self-reported trauma history with the majority [17 (77.3%)] reporting more than one traumatic event. Claustrophobia was reported in 28 (30.4%) students. Reported psychotropic medication use was minimal and therefore not analyzed.

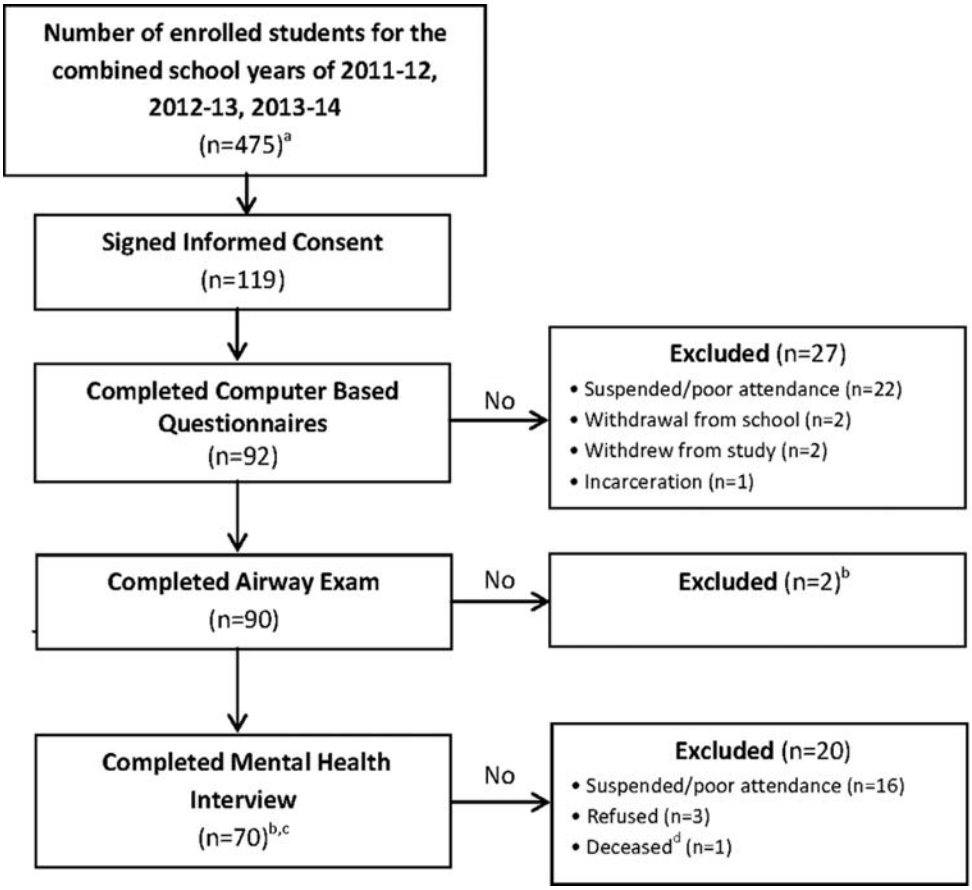

Figure 1: Flowchart of participants.
[a]Based on 225–275 registered students each school year, total enrollment for the combined school years was roughly 750 students. Due to an approximate 55% return rate each school year, a total of 475 individuals attended the high school during these three academic school years; [b]two students did not complete Airway Exam (1 refused, 1 suspended/poor attendance) of which one student completed the Mental Health Interview; [c]70 students completed all 3 components of protocol, a total of 71 students completed the mental heath interview; [d]cause of death: co-morbid medical conditions.

Self-reported sleep problems

Two-thirds of students (65 of 92) reported at least one sleep problem: poor sleep quality (46.7%), insufficient sleep (43.5%), irregular sleep pattern (28.3%), insomnia (25.0%), nightmares (20.7%), sleep movement problems (13.0%), trouble breathing during sleep (13.0%), and hypersomnia (10.9%). Given nine possible sleep problem options, students indicated an average of 2.01 (1.93) sleep conditions: 48.9% reported two or more sleep problems and 20 (21.7%) reported a single sleep problem, only 27 (29.3%) reported no sleep problems.

Subjective symptoms of poor sleep quality and insomnia

Poor sleep quality symptoms were reported in 98.9% (91/92) of students (Table 1), despite ~29% of students indicating no sleep problems. Daily caffeine intake (78.3%) and cognitive impairment defined as difficulty remembering things (76.1%), difficulty concentrating (75.0%) and difficulty paying attention (73.9%), as well as moderate/severe daytime tiredness (69.6%) and sleepiness affecting morning activity level (69.6%) were the most common symptoms of NRS, notwithstanding the lack of assessment for other etiologies for these complaints.

Average ISI score was in the mild range 9.70 (6.95), but 38 (41.3%) students reported clinically relevant insomnia (ISI ≥ 12). Difficulty returning to sleep (62.0%), frequent awakenings (58.7%) and sleep onset latency ≥45 min were the most common insomnia symptoms. Fifty-eight (63.0%) students reported waking up more than twice each night of which 38 (65.5%) had trouble returning to sleep. Insomnia behaviors of clock-watching (71/92, 77.2%) with resulting time monitoring calculations (69/92, 75.0%) and frustration (62/92, 67.4%) were

noted. Monthly or more frequent sleep aid use in 53 (57.6%) students included 44 (47.8%) using a sleep aid at least once a week (primarily marijuana, 77.3% of the 44). Average III score was 11.08 (10.64) indicative of mild to moderate impairment.

Table 1: Incidence of signs and symptoms: sleep quality, insomnia, and sleep disordered breathing risk.

Symptoms: Sleep Quality	%	Symptoms: Insomnia	%	Symptoms: SDB	%
Sleep quality: sleep period		**Insomnia: TMB/ruminate**		**SDB Risks: Objective**	
Light sleep	51.1	Clock-watching	77.2	Septal erythema	64.4
PSQ	50.0	Mental calculations	75.0	Narrow/high arched hard palate	63.3
Unrefreshing sleep	44.6	Frustration: Clock-watching	67.4	Excess soft palate tissue	62.2
		Mental Calculations=Frustration	66.3	Large tongue	53.3
Sleep quality: daytime or behavioral dysfunction		Less Sleep=Frustration	66.3	Retrognathic chin	52.2
Daily caffeine intake	78.3			Narrow/inverted dental arches	51.1
Daytime tiredness[a]	69.6	**Insomnia: behavior**		Deviated septum	47.8
Sleepiness affects AM energy	69.6	Difficulty returning to sleep	62.0	Septal swelling	34.4
Daytime sleepiness[a]	68.5	Wake up a lot	58.7	Elongated/thick uvula	33.3
Sleepiness affects PM energy	57.6	SOL ≥45 min	56.5	Airway Mallampati III	30.0
Impaired daytime function[b]	56.5	Racing thoughts prevent sleep	44.6	Airway Mallampati II	26.7
Desire to Nap[a]	45.7	ISI >12	41.3	Tonsils +3 or +4	26.7
Difficulty staying awake	44.6	Pain prevents sleep	28.3	Turbinates: swollen/enlarged	25.6
Sleep affects academics[c]	42.4	Anxiety/fear prevent sleep	17.4		
Nap: at least every other day	40.2	Poor sleep hygiene	15.2	**SDB risks: subjective**	
Difficulty visiting others	40.2			Nocturia	73.9
Difficulty relationships	39.1	**Insomnia: sleep aids**		Dry mouth in AM	70.7
Caffeine for stimulation	38.0	Sleep aid use ≥1x/month	57.6	AM headache	50.0
ESS >10	27.2	"Alcohol/Marijuana help me sleep"	50.0	NAR+	50.0
		Marijuana as a sleep aid	43.5	Allergies	38.0
Sleep quality: cognitive impairment		Non-prescription sleep aid use	22.8	Snoring	31.5
Difficulty:		Prescription sleep aid use	16.3	Other trouble breathing	17.4
Remembering things	76.1	Alcohol as a sleep aid	9.8	Cessation of breath	14.1
Concentrating	75.0			Choke/gasp for breath	10.9
Paying attention	73.9				

ASKME, Determines individual sleep perceptions in relationship to personal sleep complaints; ESS, Epworth sleepiness scale; ISI, insomnia severity index; NAR+, positive for non-allergic rhinitis; PSQ, poor sleep quality; SDB, sleep disordered breathing; SOL, sleep onset latency. [a]Moderate to severe; [b]ASKME 26: "The way I sleep affects how I function during the day"; [c]ASKME 23: "Sleepiness or tiredness have hurt my academic performance."

Sleep disordered breathing symptoms: objective and subjective

Objective airway exam data indicated high incidence of airway crowding (Table 1), with over half the students presenting with one or more of the following: high arched/narrow hard palate, excessive soft palate tissue, Mallampati II–III, tongue large for oral cavity size, retrognathic chin, narrow/inverted dental arches, and deviated septum. Untreated nasal congestion and irritation were common, the latter in the form of septal erythema, septal swelling, and swollen/enlarged turbinates. In contrast to the pervasive problems of airway crowding, less than a third of students reported classic subjective SDB symptoms: snoring, cessation of breath, choking/-gasping/struggling for breath, and other trouble breathing, (Table 1). At least 50% reported subjective physical symptoms common to SDB (dry mouth upon awakening, morning headache, and nocturia). Collectively, 73.9% were at risk for SDB based on the screening methods previously described (Figure 2).

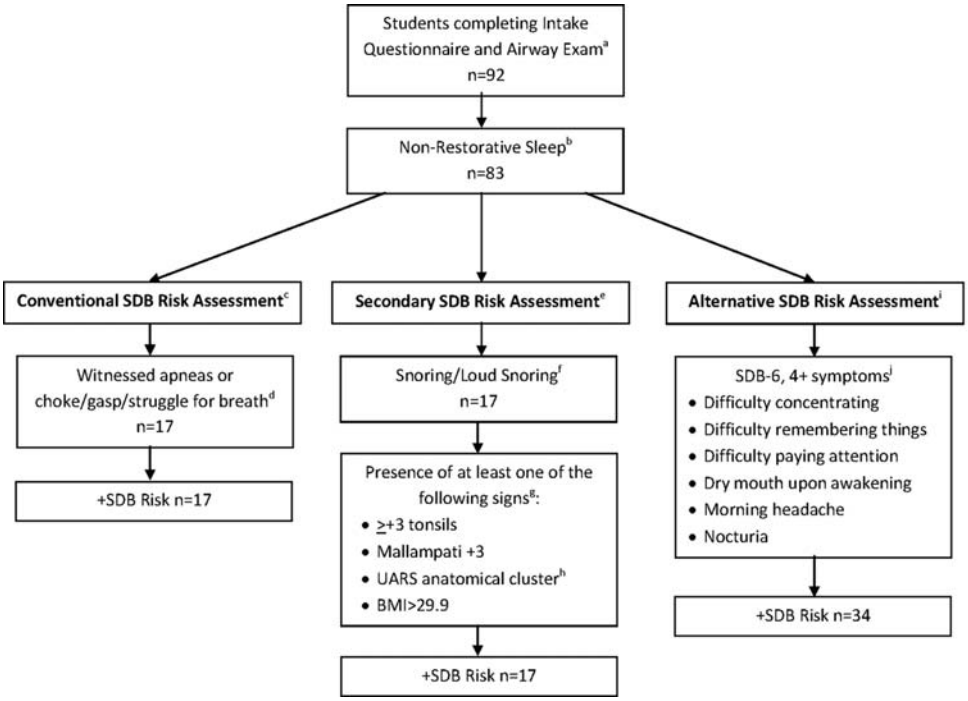

Figure 2: Screening for sleep disordered breathing risk via multiple pathways of subjective symptoms and objective signs. BMI, Body mass index; SDB, sleep disordered breathing; UARS, upper airway resistance syndrome. [a]Only 90 students completed the airway exam; [b]non-restorative sleep based on subjective response of at least one of the following (n): moderate/severe daytime sleepiness (48), moderate/severe daytime tiredness (46), light sleep (35), poor sleep quality (35), or unrefreshing sleep (32); [c]All 83 were assessed for Conventional SDB Risk; [d]witnessed apnea (10), choke/gasp/struggle for breath (10); [e]Only those without Conventional SDB Risk were assessed for Secondary SDB Risk (n = 66); [f]snoring (17), loud snoring (1); [g]≥+3 tonsils (5), Mallampati +3 (5), UARS cluster (1), BMI >29.9 (2); [h]UARS anatomical cluster included a positive identification during the physical exam of each of three symptoms: narrow hard palate, narrow dental arches, and recessed chin; [i]Only those without Conventional SDB Risk or Secondary SDB Risk were assessed for Alternative SDB Risk (n = 49); [j]difficulty concentrating (33), difficulty remembering things (32), difficulty paying attention (30), dry mouth upon awakening (28), morning headache (21), nocturia (28).

Parasomnias and limb movements

Overall, 69.6% reported parasomnias and leg movement symptoms. Parasomnias included: the feeling the body moves a lot as if acting out a dream 40 (43.5%), making disruptive noises 26 (28.2%), and sleep walking 5 (5.4%). Leg movement symptoms included symptoms of Periodic Limb Movement Disorder (PLMD) 33 (35.9%) and restless leg syndrome (RLS) 28 (30.4%).

Quality of life

Overall quality of life averaged fair to good, 3.52 (1.10) with 51 (55.4%) rating overall life as "good" or "very good" and 41 (44.6%) rating overall quality of life as "fair" to "very poor" (Figure 3).

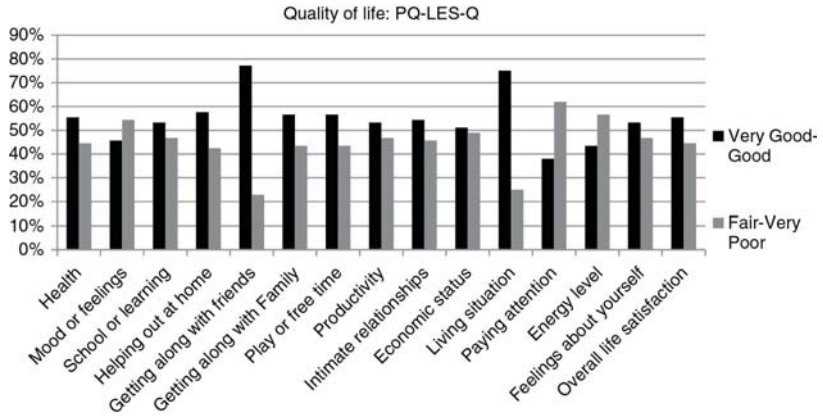

Figure 3: Responses to each question from the pediatric quality of life enjoyment and satisfaction questionnaire, n = 92.

Sleep disorders: sleep quality and quality of life

When assessing students meeting criteria or presumptively diagnosed with specific sleep disorders, we independently contrasted scores for both sleep quality and quality of life based on the presence or absence of the disorder. For this analysis, sleep quality was defined by a single item question, and quality of life was identified by overall scores from the PQ-LES-Q. In every sleep condition, students with a likely disorder indicated worse sleep quality (higher scores): insomnia (with vs. without) [4.53 (1.25) vs. 2.54 (1.38); $p = 0.001$, $g = 1.49$], SDB risk [3.63 (1.59) vs. 2.32 (1.49); $p = 0.002$, $g = 0.83$], parasomnia/limb movements [3.70 (1.54) vs. 2.57 (1.64); $p = 0.002$, $g = 0.71$] and nightmares [4.22 (1.33) vs. 2.80 (1.60); $p = 0.001$, $g = 0.94$]. The same dichotomous evaluations showed smaller but mostly significant effects for worse quality of life (lower scores): insomnia [58.13 (15.43) vs. 68.19 (18.77); $p = 0.008$, $g = 0.57$], SDB [61.86 (15.65) vs. 72.37 (24.09); $p = 0.023$, $g = 0.59$], parasomnia/limb movements [62.05 (16.38) vs. 68.56 (21.09); $p = 0.112$, $g = 0.36$], and nightmares [58.23 (16.61) vs. 67.76 (18.14); $p = 0.013$, $g = 0.54$].

Mental health

Of 71 students who completed Mental Health Interviews, average scores were: depression 12.25 (9.48), (16 mild cases, 12 moderate/severe); anxiety 12.85 (11.88), (60 mild, 11 moderate/severe); and, DSI (suicidality) 0.52 (1.35), (7 non-clinical, 4 clinical). (See Supplement for scoring details.) Traumatic imagery was present in 23 (32.4%) students: 17 (73.9% of 23) reported memories of traumatic events (mild-moderate intensity and frequency), 11 (47.8%) reported disturbing dreams (mild-moderate intensity and frequency), 11 (47.8%) reported flashbacks (moderate-severe intensity and frequency), and 11 (47.8%) reported daymares (moderate intensity and frequency). Nine (12.7%) students were diagnosed with PTSD following K-SADS-PL PTSD interview.

Nightmare frequency and impairment

For the 36 (39.1%) students suffering from monthly or more frequent nightmares, average DDNSI score was 13.33 (8.19); 22 of the 36 (61.1%) met adult criteria for a nightmare disorder [average score: 17.83 (7.34)]. These 36 indicated high degree of impairment specifically due to nightmares in the following areas: 88.9% sleep loss, 88.9% sleep quality, 86.1% sleep onset, 86.1% sleep consolidation, 72.2% daytime mood, 58.3% mental health, and, to a lesser extent, other areas relating to social, school, relationship, and physical health.

Nightmare triad syndrome

In total 70 students completed all three components of the study (Figure 1); sociodemographics were similar to the total sample. Nineteen (27.1%) students met criteria for NTS (frequent nightmares, insomnia ≥12 with impairment, and risk for SDB) (Supplement Figure 1) and 51 (72.9%) did not. There were significant differences in qualifying metrics (NTS+ vs. NTS−) (Table 2): 11.42 (14.68) vs. 1.65 (5.60) nightmares/month, average ISI 16.89 (3.49) vs. 7.16 (6.09), and percent at risk for SDB 100.0% vs. 64.7%. Significant differences were noted

in other measures (NTS+ vs. NTS−): III [19.84 (10.48) vs. 7.35 (9.29): p = 0.001, g = 1.28], ESS [10.42 (4.40) vs. 5.57 (4.54): p = 0.001, g = 1.07], and parasomnias or limb movements (94.7% vs. 62.7%; p = 0.008). Moderate or severe daytime sleepiness (31.6% vs. 19.6%; p = 0.343), moderate or severe daytime tiredness (36.8% vs. 19.6%; p = 0.208), and suicidality [1.16 (2.06) vs. 0.29 (0.90), p = 0.016] were all worse in the NTS+ group but statistical significance was not established, potentially due to power limitations.

Table 2: Comparison of nightmare triad syndrome (+) and nightmare triad syndrome (−) students for quality of life, mental health, sleep disordered breathing risk, disturbing dream and nightmare severity index, and insomnia severity index scores.[a]

	Total (n=70)	NTS+ (n=19)	NTS− (n=51)	p-Value; g[b]
PQLES-Q				
1. Physical health	3.51 (0.94)	2.95 (1.03)	3.73 (0.83)	0.002; 0.87
2. Mood/feelings	3.39 (1.05)	3.05 (1.03)	3.51 (1.05)	0.106; 0.44
3. School/learning	3.59 (0.97)	3.37 (1.12)	3.67 (0.91)	0.254; 0.31
4. Household activities	3.71 (0.92)	3.68 (0.95)	3.73 (0.92)	0.842; 0.05
5. Social relationships	4.11 (0.81)	3.74 (0.93)	4.25 (0.72)	0.018; 0.65
6. Family relationships	3.71 (0.99)	3.42 (0.96)	3.82 (0.99)	0.134; 0.40
7. Leisure time activities	3.70 (1.01)	3.26 (1.05)	3.86 (0.96)	0.027; 0.60
8. Productivity	3.67 (0.94)	3.47 (0.84)	3.75 (0.98)	0.274; 0.29
9. Intimate relationships	3.34 (1.44)	2.89 (1.29)	3.51 (1.47)	0.110; 0.43
10. Economic status	3.41 (1.10)	2.89 (1.10)	3.61 (1.04)	0.014; 0.67
11. Living/household situation	4.10 (0.71)	3.79 (0.71)	4.22 (0.67)	0.022; 0.62
12. Paying attention	3.24 (0.95)	2.74 (0.73)	3.43 (0.96)	0.006; 0.75
13. Energy level	3.50 (0.97)	3.11 (0.94)	3.65 (0.96)	0.039; 0.56
14. Feelings about self	3.53 (0.99)	3.05 (1.13)	3.71 (0.88)	0.012; 0.69
15. Overall Life satisfaction and contentment	3.51 (1.05)	3.05 (1.13)	3.69 (0.97)	0.022; 0.62
16. PQLES-Q total score[c]	65.23 (15.87)	56.11 (14.63)	68.63 (15.06)	0.003; 0.84
Mental health				
Beck anxiety	12.77 (11. 95)	20.47 (14. 38)	9.90 (9.58)	0.001; 0. 95
Beck depression	12.27 (9.54)	18.53 (11. 76)	9.94 (7.45)	0.001; 0. 97
Suicidality subscale	0.53 (1.36)	1.16 (2.06)	0.29 (0.90)	0.016; 0.66
Traumatic imagery Scale	7.43 (14.12)	12.47 (17.35)	5.55 (12.39	0.035; 0.49
DDNSI[d]	4.96 (7.80)	13.39 (8.08)	1.81 (4.83)	0.001; 1.95
ISI[e]	9.80 (7.01)	16.89 (3.49)	7.16 (6.09)	0.001; 1.74
SDB risk[f]	55, 79%	19, 100%	36, 71%	0.007

DDNSI, Disturbing dream and nightmare severity index; ISI, insomnia severity index; NTS, nightmare triad syndrome; PQLES-Q, Pediatric Quality of Life Enjoyment and Satisfaction Questionnaire; SDB, sleep disordered breathing. [a]Average scores expressed as mean (standard deviation), or n, % of total; [b]Hedges g; [c]PQLES-Q Score is expressed as a % of maximum score, with higher percentages indicating greater quality of life; [d]DDNSI determines nightmare frequency and their effects: scores ≥10 are indicative of a nightmare disorder; [e]ISI measures insomnia severity, high scores indicate greater insomnia severity; [f]SDB reported as a dichotomous variable based on metrics outlined in methods section of the paper, p-value based on χ^2 analysis.

Advanced analyses of NTS patients

NTS+ individuals reported significantly lower quality of life [56.11 (14.63)] than NTS− [68.63 (15.06), t(68) = 3.12, p = 0.003; g = 0.84]. To better understand how NTS affects quality of life, we examined the relations between NTS and individual items on the PQ-LES-Q. These results are exploratory and correction for multiple comparisons were not utilized. Compared to NTS−, NTS+ individuals reported less satisfaction relating to their health [t(68) = 3.28, p = 0.002, g = 0.84], not getting along with friends [t(68) = 2.47, p = 0.016, g = 0.61], less satisfaction with play or free time [t(68) = 2.27, p = 0.026, g = 0.59], less satisfaction with buying things [t(68) = 2.51, p = 0.014, g = 0.66], lower satisfaction with living situation [t(68) = 2.31, p = 0.023, g = 0.61], greater difficulty with attention [t(68) = 2.84, p = 0.006, g = 0.80], lower energy levels [t(68) = 2.12, p = 0.038, g = 0.56], and feeling poorer about themselves [t(68) = 2.56, p = 0.013, g = 0.65]. Surprisingly, we found no significant difference between NTS+ and NTS− for satisfaction with school or work [t(68) = 1.15, p = 0.256; g = 0.29].

As hypothesized, NTS+ had higher levels of depression symptoms [18.53 (11.76)] than NTS− [9.94 (7.45), t(68) = 3.63, p = 0.001 g = 0.86]. Similarly, NTS+ had higher levels of anxiety symptoms [20.47 (14.38)] than NTS− [9.90 (9.58), t(68) = 3.56, p = 0.001, g = 0.86].

Our final aim assessed whether a direct effect of NTS on overall quality of life remained after statistically controlling for symptoms of depression and anxiety. As predicted, there was a significant indirect effect of NTS

through depressive symptoms affecting quality of life (B = −0.06, SE = 0.02, 95% CI −0.1246 to −0.0294); but, after statistically controlling for the effects of depressive symptoms there was no longer a direct effect of NTS on overall quality of life (B = −0.06, SE = 0.04, 95% CI −0.1418 to 0.0200, p = 0.138). Anxiety also mediated the relations between NTS and quality of life. As predicted, there was a significant indirect effect of NTS through anxiety symptoms affecting quality of life (B = −0.04, SE = 0.02, 95% CI −0.0960 to −0.0045). And, after statistically controlling for the effects of anxiety symptoms there was a remaining significant direct effect of NTS on overall quality of life (B = −0.09, SE = 0.04, 95% CI −0.1684 to −0.0023, p = 0.044). Therefore, our hypothesis was partially supported, as NTS was associated with quality of life independent of anxiety symptoms, but not independent of depressive symptoms.

Discussion

Among a medium-sized cohort (n = 92) of at-risk high school students, an in-depth sleep evaluation revealed a high prevalence of sleep complaints, signs and symptoms indicating independent sleep disorders, and a propensity for multiple sleep disorders in nearly half the students. Overall, a wide range of presumptive sleep disorders were screened for and identified: NRS, insomnia, SDB, nightmares, parasomnias, and restless legs and leg jerks. Of potential clinical import, although nearly a third of participants indicated no sleep problems, 98.9% of students reported symptoms of poor sleep quality. The likely presence of a sleep disorder was associated with worse global sleep quality, demonstrating medium to large effects, as well as worse quality of life, showing small to medium effects.

Furthermore, notwithstanding the lack of objective diagnostic polysomnography, the constellation of physical findings due to airway crowding and obstructed anatomy indicate that presumptive SDB was highly prevalent in the sample. SDB may be frequently overlooked in adolescent populations; it presents in atypical fashion and the index of suspicion may be low [72], [73], [74]. Various symptoms such as NRS, hyperactivity, poor cognitive function, mental instability, daytime sleepiness, daytime tiredness, decreased motivation, lack of energy, difficulty making decisions or even non-specific symptoms such as morning headaches, dry mouth, or nocturia may lead clinicians down numerous pathways examining a host of other pathophysiological conditions, only to consider sleep evaluations and objective sleep testing as a last resort [68]. Yet, diagnosis and treatment of SDB has the potential to markedly improve sleep quality and lead to profound effects on all aspects of health (mental, physical, emotional) and in turn improve quality of life [75], [76], [77].

These physical findings were identified in a population of students struggling to succeed in academic environments. Moreover, beyond the sleep disrupting effects of presumptive SDB, the further high incidence of other sleep disrupting symptoms, (insomnia, PLMD/RLS, nightmares, and parasomnias) would compound the deleterious impact of poor sleep quality [14], [33], [78]. Acute and chronic difficulties with drug use could also aggravate cognitive impairment and affect executive functioning in these adolescents [79], [80]; and chronic opiate use aggravates sleep breathing disorders [81]. Notwithstanding the obvious selection bias in this study, this cohort of students suffered from conditions that may potentially affect their ability to achieve success academically and in jobs or relationships [29]; that so many students suffered clusters of sleep disorders may prove clinically relevant.

Among various clusters, the most prominent was the subset of students (n = 19) presumptively diagnosed with NTS, which may reflect the most harmful combination of sleep disorders. Though NTS is a recently described and not a well delineated syndrome, the data clearly showed students presenting with the three disorders (nightmare frequency, insomnia severity, and greater SDB risk) demonstrated the worst quality of life compared to those without NTS. Students with NTS also scored notably higher for depression, anxiety, suicidal ideation, and traumatic imagery than students without the syndrome.

Additionally, the presence of NTS revealed a consistent pattern of worse quality of life on many PQ-LES-Q subscales, with medium to large effects for physical health, paying attention, feelings about self, economic status, social relationships, living situation, leisure time, and energy level in descending order of effect sizes (all effects >0.50). Though these findings are correlations and do not indicate causality, the individual disorders making up NTS have already been proven to yield worse outcomes for these same factors listed above [10], [26], [27], [34]. Given the reasonable potential that NTS is worsening the quality of life of these students, it would not be surprising to learn in future studies that this deleterious impact in so many areas of human behavior and quality of life would aggravate psychosocial problems, a number of which these students were currently reporting or which perhaps previously led them to the point of entering this highly specialized chartered school. The presence of this unusual co-morbidity (nightmares, insomnia, and SDB) in 19/70 students supports the need for research to evaluate the extent of impairment in daytime functionality, productivity, and mental health.

The combined effect of this triad of sleep disorders disrupting nightly sleep may also explain daytime fatigue and malaise, which could aggravate a behavioral model of depression. However, depression and anxiety can independently compromise quality of life. Our findings show that NTS was associated with quality of life independent of the effects of anxiety, but not depression. Then again, these mediational analyses are also underpowered, and it is conceivable that NTS would be found to be independent of depression in a larger sample. Therefore, our results indicate a need for further research utilizing larger samples to tease apart the complex relationships between clusters of sleep disorders and mental health disorders [82].

The observations from the current study may not only benefit the students but also educators and support staff. These data can help direct individual educational plans or behavioral intervention plans by screening for underlying sleep disorders. The combined signs and symptoms of sleep disorders and inevitable poor sleep quality can have significant impact on daytime achievements. Sleep-related cognitive impairment aggravates academic difficulty as students have trouble paying attention, understanding new concepts, retaining knowledge, engaging in problem solving, and poor memory recall. Furthermore, NRS can also lead to poor decision making as immediate gratification for short term rewards trumps long term consequences. Insufficient sleep or poor sleep quality also compromises or impairs coping mechanisms: tired people tend to be more emotionally reactive and cannot easily access their rational mind. If sleep quality were improved, these students would have additional resources to help them focus and learn in class, to weigh their options before making decisions, and to cope with daily life stressors in alternative ways. We are not suggesting that improved sleep quality would turn at-risk adolescents into exemplary students, but there is a probability, as yet to be determined, that improved sleep quality would have a positive impact.

More research is needed to understand compounding and confounding variables: trauma history, substance abuse, disadvantaged socioeconomic status, unstable living conditions, and untreated physical/mental conditions may all increase the risk for sleep disorders. Prevalence studies in adolescents are needed to identify common sleep disorder clusters and accurately identify mental health disorder prevalence (a distinct, independent cause of sleep disorders). Future studies should include nocturnal polysomnography; SDB and parasomnias diagnosis would provide clearer insight into the degree of sleep fragmentation. Longitudinal analysis clarifying the role sleep disruption plays in psychopathology and in reduced quality of life will direct future research examining the effects of treatment in at-risk adolescents with sleep disorders (including investigating the role of depression, anxiety, and traumatic exposure in those undergoing sleep therapies). Such research would create more efficacious treatment regimens for adolescents with sleep disorders or complex clusters of co-morbid sleep conditions. Identifying NTS prevalence in other populations could help to direct treatment and preventative steps as well as understanding its chronic impact [1], [10], [83], [84], [85]. And, comparing the impact of a single disorder on quality of life and the impact of NTS on quality of life would clarify the severity of this syndrome. Special recruitment strategies may help with self-selection bias, and exploring the role of low socio-economic status within health care systems may be valuable.

There are several limitations in these data. Selection bias likely occurred: students aware of sleep problems and parents with concerns for their child's sleep were probably more likely to enroll in the study. There also may have been students who wanted to participate but were unable to obtain parental consent or were concerned with discussing difficult/uncomfortable topics with school social workers. Although measures were taken to help students who were either English as a second language learners or low readers, students may have avoided participation for these reasons. However, studies of sleep disturbances with at-risk children are rare, and our findings demonstrate the need for more research in larger samples. Our study was also limited by only having one assessment time point. Given the cross-sectional nature, we could not determine whether the nightmare triad in theory leads to depression and lower quality of life; and, our mediational analyses are limited to assessing atemporal mediation [86]. Future research would benefit from having several time points to establish temporal precedence and to find causal relations. Despite this small sub-sample (19 NTS+ students), the findings suggest a clinically relevant detrimental effect as evidenced by the association between NTS and worse quality of life, and thus, warrant further research with a larger sample. Due to low incidence, data analysis on students taking psychotropic or opiate medications was not feasible. Unreported recreational drug use may have affected sleep, health, quality of life, and cognitive function. Although there was no control group (normal adolescents), this study is a useful first step in understanding the impact of sleep disturbances among at-risk students.

Conclusion

Presumptive sleep disorders were highly prevalent in a sample of at-risk adolescents. Regardless of which sleep disorder or combination of sleep disorders cause a student to suffer from poor sleep quality, the daytime effects are clinically relevant and may impact academic performance, decision making, and ability to function as a healthy member of society. If future research identifies lower prevalence of sleep disorders in normal compared

to at-risk adolescents, then proper diagnosis and treatment may prove a key factor in enhancing opportunities for these vulnerable individuals. Primary care physicians, parents, and educators would benefit from training programs to identify classic and atypical sleep disorder presentations to facilitate diagnosis and treatment in at-risk students.

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Conflict of interest: Authors NDM, JK, MRN, VAU, and RB declare that they have no conflict of interest. Author BK reports: 6 main activities related to my work in sleep medicine:

For websites, I own and operate 6 sites that provide education and offer products and services for sleep disorders patients:www.nightmaretreatment.com: www.ptsdsleepclinic.com: www.sleeptreatment.com: www.sleepdynamictherapy.com: www.soundsleepsoundmind.com: www.nocturiacures.com.

For other professional services, I am the medical director of a national DME company Classic Sleep Care for which my sole functions are consultation and QA; I have neither patient encounters nor do I benefit from the sale of any DME equipment.

For intellectual property, I market and sell 3 books for sleep disorders patients: *Insomnia Cures*, *Turning Nightmares into Dreams*, and *Sound Sleep, Sound Mind*.

For clinical services, I own and operate one commercial sleep center: Maimonides Sleep Arts & Sciences, Ltd.

For educational and consulting services: I conduct CME/CEU educational programs for medical and mental health providers to learn about sleep disorders. Sometimes these programs involve the attendee paying a fee directly to our center. Other times, I conduct the workshops at other locations, which may be paid for by vendors such as Respironics and RESMED or other institutions such as the AMEDDC&S, VAMC, and regional sleep center conferences.

I am also president and principal investigator of a non-profit sleep research center, the Sleep & Human Health Institute (www.shhi.org) that occasionally provides consultation services or receives grants for pilot studies, the most recent: ResMed ~$400,000 January 2015 (funding for randomized control trial of treatment in insomnia patients).

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